

# *Smart Grid Deployment Plan*

## *Smart Utility – Grid Reliability & Resiliency Goals*



# **GRID RELIABILITY & RESILIENCY GOALS**

## ***Smart Utility Vision***

- **Transmission**

- Implement project to improve speed of response to grid issues
- Better utilization of data to proactively avoid issues
- More efficient utilization of resources

- **Distribution**

- Create a self-healing and resilient grid via real-time information
- Expand communications and remote control of devices
- Provision of balancing, storage, reliability and integration services to customers

# GRID RELIABILITY & RESILIENCY GOALS

## Utilization of Distribution Automation

### SUMMARY OF CURRENT 12KV SUBSTATION SCADA ALLOCATION (As of 1/25/2011)

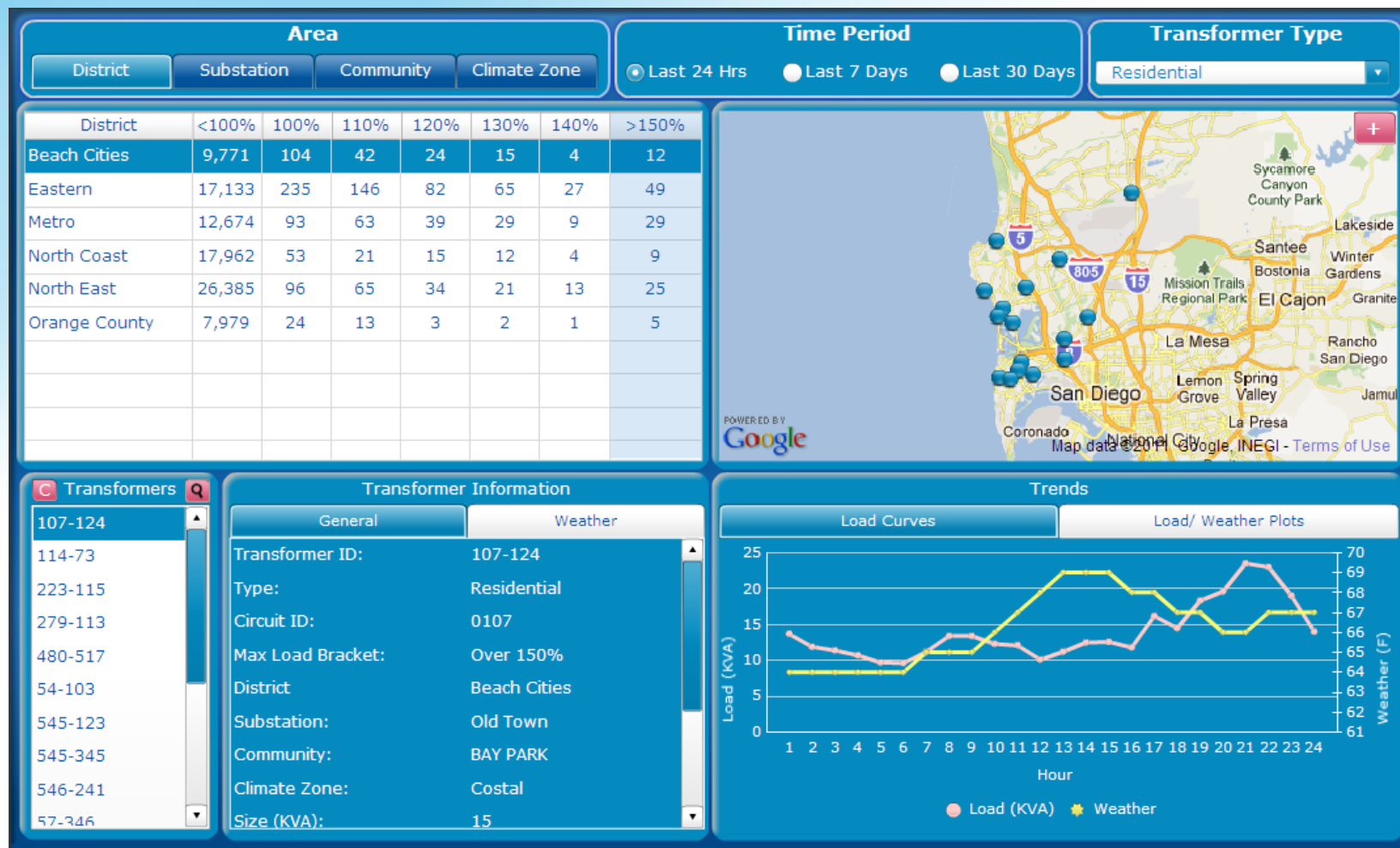
*Note: Figures represent 12kV distribution only. Additional customers are served on 4kV distribution.*

	SCADA	NON-SCADA	TOTAL
SUBSTATIONS	79	27	106
CIRCUITS (with SCADA @ SUB)	673	100	773
CUSTOMERS (with SCADA @ SUB)	1,111,915	150,763	1,262,678
FORECASTED LOAD (MW)	4573	526	5099

- Distribution Planning utilizes SCADA to plan and design the system
- Distribution Operations can remotely operate breakers and switches
- Remote control of devices to automate functions
- Data used to investigate customer issues
- Diagnose and solve system problems
- Expedite electric load curtailment activities

# GRID RELIABILITY & RESILIENCY GOALS

## AMI Data Mining



# GRID RELIABILITY & RESILIENCY GOALS

## ***Outage and Distribution Management System***

Scope: The new system will interface with SDG&E Geographic Information System (GIS) data, real-time information from Supervisory Control and Data Acquisition (SCADA), Condition-Based Maintenance (CBM) and Smart Meter systems to detect outages and develop plans to restore service to customers

### Timeline:

- Jan – Mar: End to End and User Acceptance Testing
- April – June: Training
- May 31<sup>st</sup>: Storm Drill
- Early July: Go Live

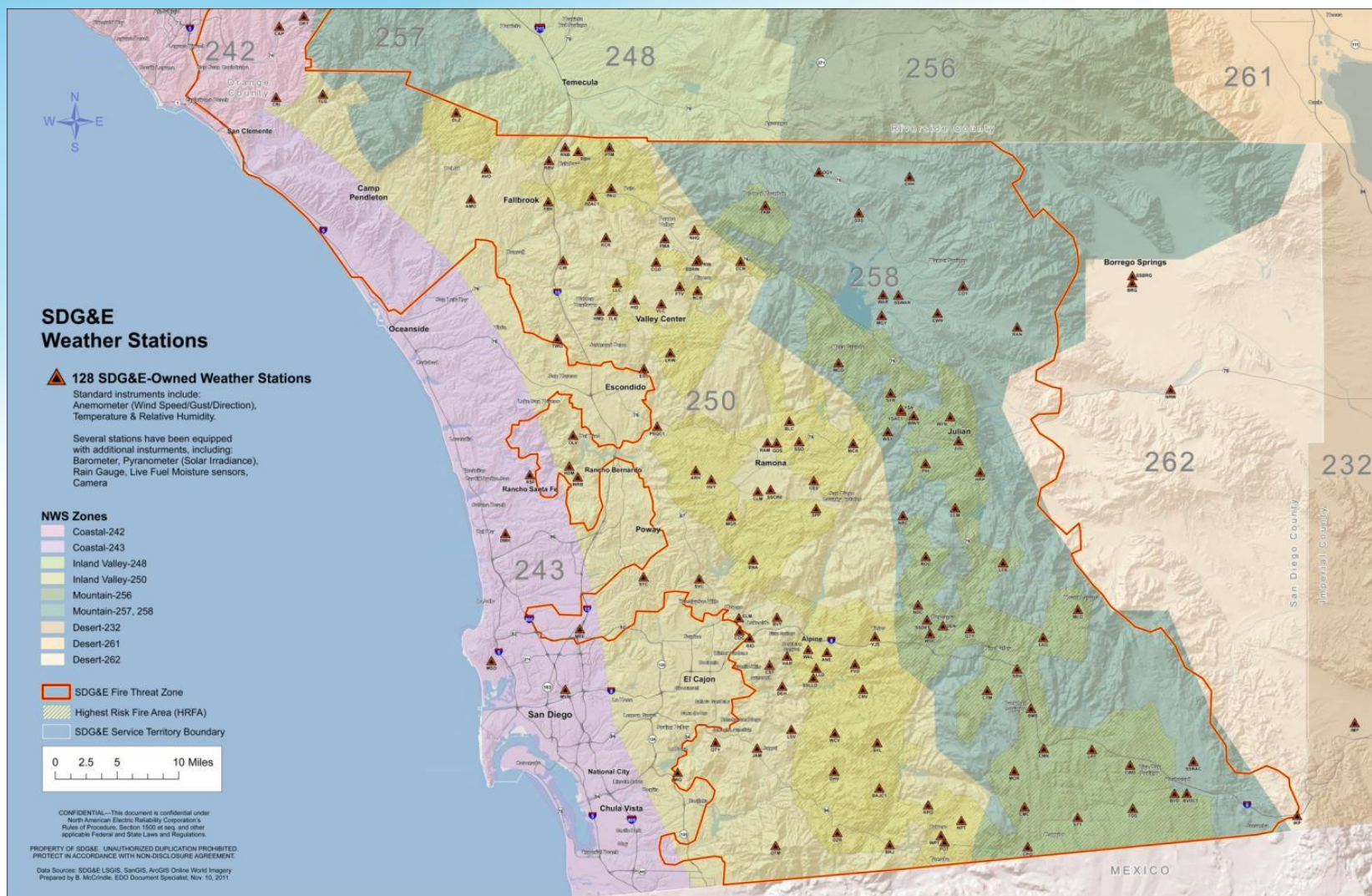
### Functionality:

- Distribution management - Access to near real-time information to assist with system optimization
- Unplanned Outages – Faster and better prediction of power system failure points
- Planned Switching - Automate the generation of daily switching plans for working on the electric distribution system
- Major events - Improve the assessment, restoration planning and execution procedures
- Reliability reporting – Automate the validation of the outage restoration reporting process



# GRID RELIABILITY & RESILIENCY GOALS

## Fire Hardening Efforts

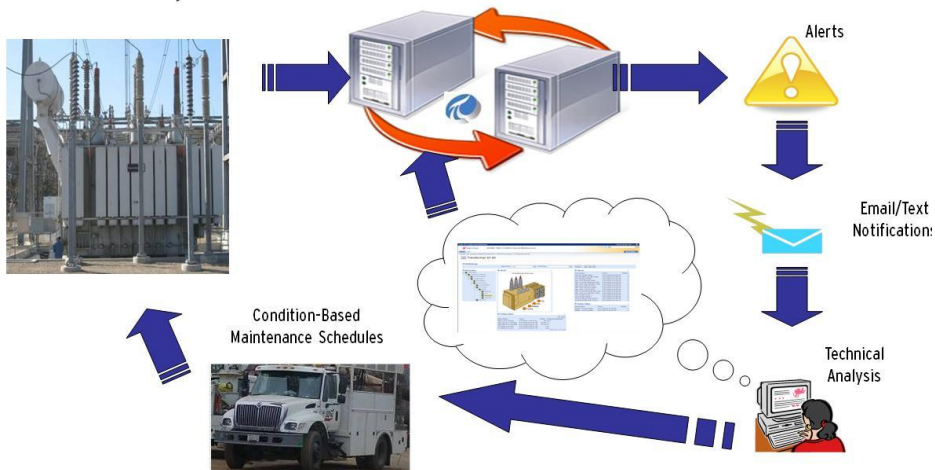


# GRID RELIABILITY & RESILIENCY GOALS

## Conditioned Based Maintenance (CBM)

<b>Project Description:</b>	<i>CBM will allow SDG&amp;E to extend the useful life and make greater utilization of transmission and distribution substation assets by using technology to monitor the assets' health and performance.</i>
<b>Current Status:</b>	<i>Currently installed at 52 of 111 substations year end 2011 98 Distribution substations and 17 transmission substation year end 2015</i>

Substation Monitoring



### What Does CBM Monitor on Distribution Transformers?



- Oil Temperature
  - Top Oil
    - LTC
    - Main Tank / LTC Differential
  - Winding Hot Spot Temperature (Calculated)
  - LV Load Current
  - Ambient Temperature
  - Hydrogen / Moisture Monitor
  - Cooling System Manager / Monitor
  - LTC Position Indication & Operations Counter
  - LTC Motor Energy Monitor
  - HV Bushing Power Factor Monitor
  - On-line Main Tank 3 gas DGA Monitor
  - On-line LTC Tank DGA Monitor (selected units)
  - LTC Vacuum bottle integrity
  - Nitrogen Pressure
- Detect Loss of Cooling Fans/Pumps
  - Detect Failed Control Contactor for Cooling Fans/Pumps
  - Collect Data on Run Hours for Fans/Pumps

# GRID RELIABILITY & RESILIENCY GOALS

## *Levels of PV on the Grid*

- **Voltage**
  - Overvoltage
  - Voltage fluctuations
  - LTC/regulator/cap bank impact
  - Unbalance
- **Protection**
  - Unintentional islanding “potential”
    - Load mismatch
    - Interconnect transformer connection
  - load rejection overvoltage
  - Reverse power (directional relaying)
  - Voltage events
  - Frequency events
- **Operational**
  - Intermittency/Variability
  - Observability/ Monitoring
  - Forecasting PV levels
  - Off Peak production
- **Demand/Energy**
  - PV impact on peak demand/load growth
  - Annual losses
  - Annual energy consumption
  - Impact on CVR
- **Thermal overloads**
- **Power Quality**
  - Harmonics
  - Flicker
  - CEBMA Violations
- **Utility Safety Practices**
  - Lineman practices
  - Hotline/deadline work
  - Improved mapping and tracking of PV to ensure safety

# GRID RELIABILITY & RESILIENCY GOALS

## *Solutions?*

- **Circuit modifications**

- Impedance modification
- Controls

- **Demand response**

- Slower  $dP/dt$  events?

- **4 quadrant control**

- Utility dynamic VAR devices
- Utility storage
- Customer inverters/storage

- **Regulatory/Standards Change**

- Existing Rules require modification to accommodate high PV penetration
  - Draft IEEE 1547.8, IEC 61850 can be utilized today
  - Similar to German Grid Code

# GRID RELIABILITY & RESILIENCY GOALS

## Asset Management – Replacement Strategies

### Predicted Cable Failures Derivation

Let

Installed Base Miles = B

Cummulate Miles remaining in Year n = MR(n)

Failures in Year n = F(n)

Failure Rate (as a function of remaining cable) in Year n = FR(n)

Average Miles per Failure = AMF

Proactive Replacement Miles in Year n = PM(n)

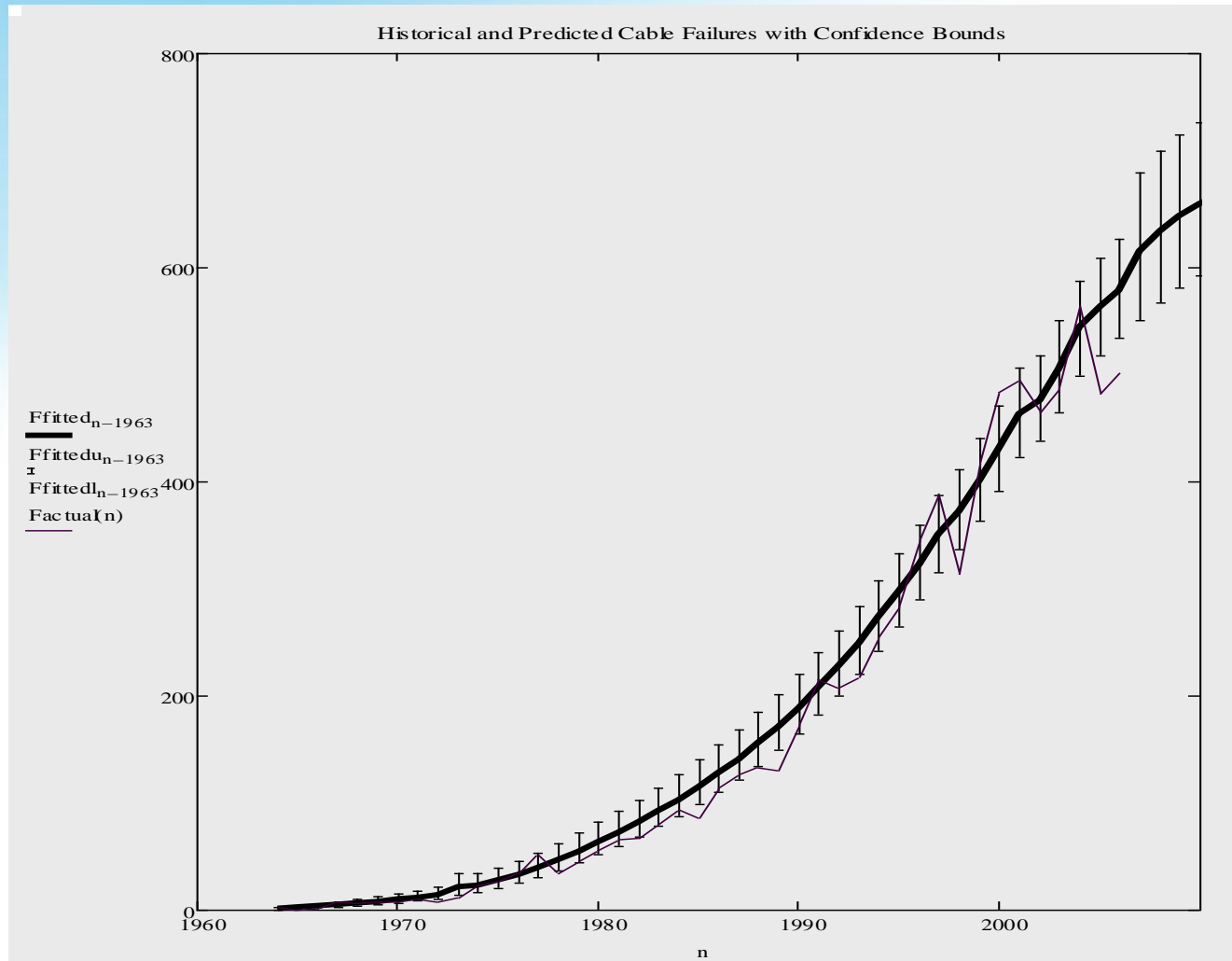
Probability that Proactive Replacement Prevents a Failure in Year n = P<sub>n</sub>

P<sub>n</sub> is the expected value of a Hypergeometric distribution

Time	Cummulative Miles Remaining	Failures	Proactive
0	MR(0) = B	0	0
1	MR(1) = MR(0) - (F(1)·AMF + PM(1))	$F(1) = \frac{FR(1) \cdot B - P_1 PM(1)}{AMF}$	PM(1)
2	MR(2) = MR(1) - (F(2)·AMF + PM(2))	$F(2) = \frac{FR(2) \cdot MR(1) - P_2 PM(2)}{AMF}$	PM(2)
3	MR(3) = MR(2) - (F(3)·AMF + PM(3))	$F(3) = \frac{FR(3) \cdot MR(2) - P_3 PM(3)}{AMF}$	PM(3)
n	$MR(n) = B - \left( AMF \cdot \sum_{i=1}^n F(i) + \sum_{i=1}^n PM(i) \right)$	$F(n) = \frac{FR(n) \cdot MR(n-1) - P_n PM(n)}{AMF}$	PM(n)

# GRID RELIABILITY & RESILIENCY GOALS

## Asset Management – Replacement Strategies



# **GRID RELIABILITY & RESILIENCY GOALS**

## ***Asset Management – Replacement Strategies***

- **Cable failure tracking method**
  - Data collection
    - Outage reports
    - Map review
    - As-built
    - Equipment failure reports
  - Cable failure database
- **Cable failure rates**
  - Use of cable failure database
  - Statistical method for determining failure rates
  - Examples of cable failure rates
  - Feeder and branch circuit reliability model

# GRID RELIABILITY & RESILIENCY GOALS

## Asset Management – Replacement Strategies

Failure rates by conductor mile in outages/year		
Cable Type	All vintages	Bad vintages
XLPE-PEJ	0.00073	N/A
XLPE	0.554	0.643
HMWPE	0.102	0.155

Options	CAIDI Gain	Units
Sub-Fusing	N/A	N/A
Looping	48	minutes
Fault Indicator Addition	20	minutes
Cable Change Out	N/A	N/A

Other Constants	
System Average CAIDI (min)	217
System Customers	1,300,000
LACC Factor	0.1211

Annualized Cost Savings per circuit foot:		
Cable Type	vintages	Bad vintages
XLPE	\$ 3.40	\$ 3.96
HMWPE	\$ 0.63	\$ 0.95

	Phase
Cable Replacement Cost	\$ 6.50 Single phase
(per foot)	\$ 9.30 2-phase
	\$ 12.00 3-phase

DO NOT CHANGE ANY DATA ABOVE THIS GRAY LINE.

Cable Change Out		
Item	Phase	Quantity
Main Branch Total Footage	Single	-
	2-phase	-
	3-phase	-
Replaced Branch Footage	Single	-
	2-phase	-
	3-phase	-
Failure Rate		0.643
Annualized Cost Savings Rate	\$	3.96
Branch Total Customers		272
Cable Replacement Cost	\$	-
Other Costs	\$	-
Project Cost	\$	-
Gain In Number of Failures		0.00000
SAIDI Gain		-
SAIFI Gain		-
PBR Gain	\$	-
Annualized Cost Savings	\$	-
<b>RTR</b>		<b>0.000</b>

Sub-Fusing		
Item	Phase	Quantity
Main Branch Total Footage	Single	-
	2-phase	-
	3-phase	-
Sub-fused Branch Footage	Single	-
	2-phase	-
	3-phase	-
Failure Rate		0.643
Branch Total Customers		272
Sub-fused Branch Customers		58
Project Cost	\$	25,000
SAIDI Gain		-
SAIFI Gain		-
PBR Gain	\$	-
<b>RTR</b>		<b>0.000</b>

Looping		
Item	Phase	Quantity
Main Branch Total Footage	Single	-
	2-phase	-
	3-phase	-
Failure Rate		0.643
Branch Total Customers		272
Project Cost	\$	25,000
SAIDI Gain		-
PBR Gain	\$	-
<b>RTR</b>		<b>0.000</b>

Fault Indicator Addition		
Item	Phase	Quantity
Main branch total footage	Single	-
	2-phase	-
	3-phase	-
Failure Rate		0.643
Branch Total Customers		272
Project Cost	\$	8,000
SAIDI Gain		-
PBR Gain	\$	-
<b>RTR</b>		<b>0.000</b>

436

d2721874412

INPUT IS ONLY REQUIRED IN THE TAN CELLS.

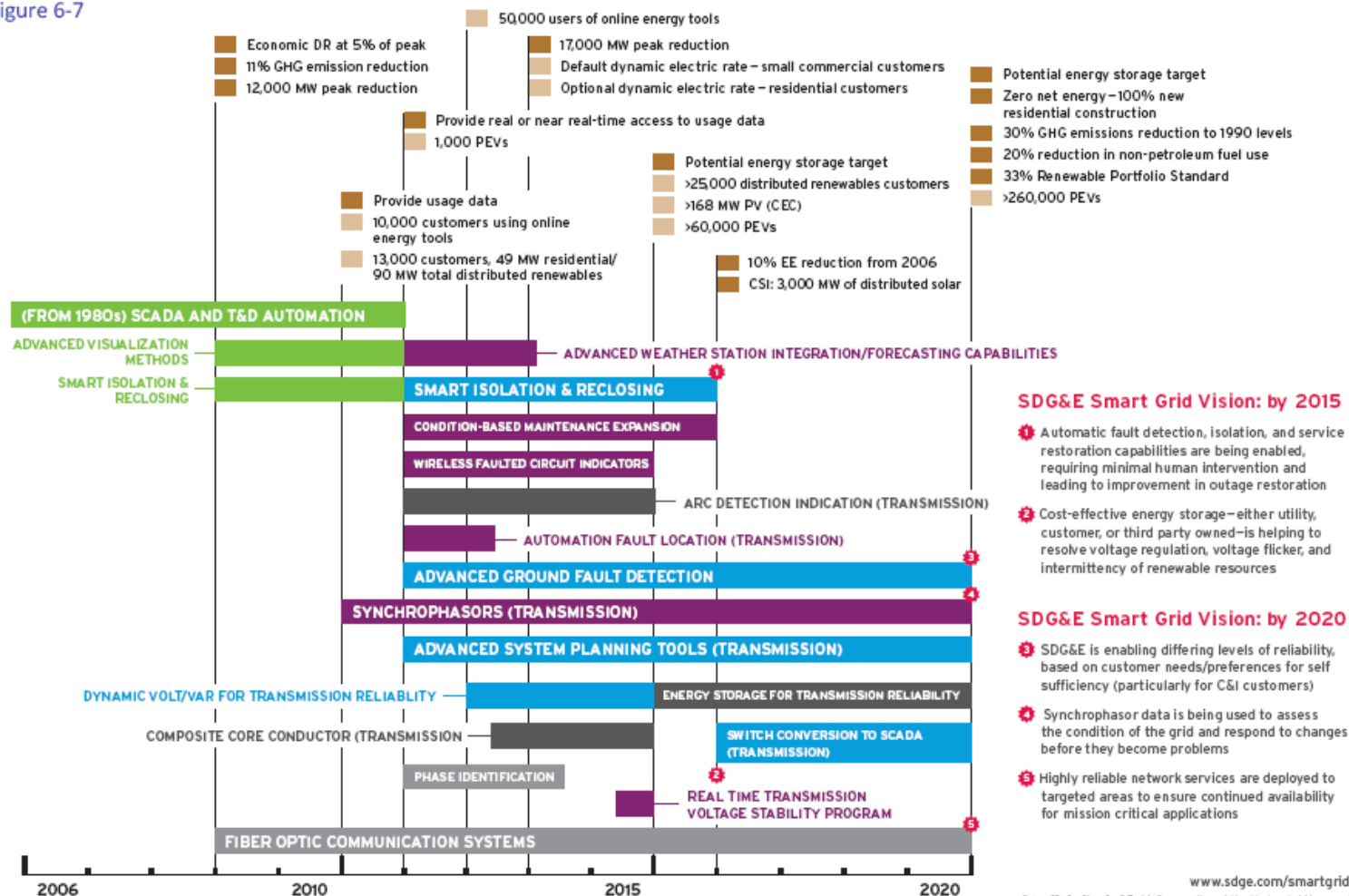
# GRID RELIABILITY & RESILIENCY GOALS

## RELIABILITY AND SAFETY

### Key

- Policy Goal
- Forecast
- SDG&E Smart Grid Vision
- In Flight Project
- New Project - Policy
- New Project - Value
- New Project - Pilot
- Enterprise Project

Figure 6-7



# **GRID RELIABILITY & RESILIENCY GOALS**

## ***Summary***

- **Smart Grid is an evolution not a revolution**
  - Pace of technology adoption has increased
- **Distribution automation is a foundational technology**
- **With AMI fully deployed the next task is mining the data**
- **Foundational IT upgrades essential to future SG technologies**
- **Mitigation strategies for renewables should be more cost effective with SG technologies**
  - Potentially allow higher penetrations than traditional solutions
- **Modern communication system is essential for future SG deployment**
- **CA energy policies require a proactive approach**
  - Exploring alternative SG service delivery models, microgrids
  - SG project portfolio in GRC application
  - SG deployment filed with the CPUC